AMERICAN

RAILROAD JOURNAL,

AND

MECHANICS' MAGAZINE.

No. 10, Vol. IX. New Series.] NOVEMBER 15, 1842. [Whole No. 417 Vol. XV.

For the American Railroad Journal and Mechanics' Magazine.]

DESCRIPTION OF THE LONG ISLAND RAILROAD, WITH SOME REMARKS ON THE PRESENT CONDITION OF THE WORK.

The importance of the Long Island Railroad, as affording the means of communication with distant points of the island, and as one of the links in the chain of connection with Boston, has hitherto received a share of public attention, and efforts tending towards the completion of the road have been vigorously made, which so far as persevered in, have been successful.

Passing over the early history of this enterprise, and its completion as far as Hicksville, 26¼ miles, it will only be the object of this communication to detail the progress, and present condition of the work east of the latter place. The whole line of which has been permanently located as far as Jamesport, a distance of 54 miles from Hicksville, 80 from Brooklyn, and within 15 miles of the intended termination at Greenport.

The second division of the road commences at Hicksville, and the construction of the same was began in the spring of 1840, and completed for the most part in the winter following, and is now in operation. The line leaves the latter place by curving to the right and pursuing a south-easterly course passes over the plains of Oyster Bay, four miles, when it again deflects to the left in turning the south flank of the hills found stretching northward along the

line dividing Oyster Bay and Huntington, and from thence on a course of about ten degrees north of east to the vicinity of Ronkonkoma pond, eighteen and a half miles additionally, passing a small but well cultivated section of country, near Farmingdale, soon after leaving which the line traverses the famous pine plains of the island, which afford but little evidence of cultivation within the vicinity of the road for upwards of forty miles. Although the division extends but twenty miles east of Hicksville to the head of Connectiquot river about three miles southwest of Ronkonkoma pond, a point equi-distant between Islip and Smithtown. The grades on this portion of the line do not exceed 26.40 per mile, and are for the most part under 10 feet per mile, and the minimum radius of curvature, 1146 feet. The soil which is uniformly sand, or gravel, or both combined, is favorable to the cost of the road, and affords an excellent road bed for the superstructure. The estimate of the entire cost of this division, inclusive of contingencies was $9,000 per mile, but will not probably exceed $8,400 per mile. The graduation is received as finished, and the superstructure as completed 17¼ miles to Suffolk station, being on a continuous line of 44½ miles from Brooklyn. The width of the road east of Hicksville, which is graded for a single track, is 13 feet in excavations, and embankments, and the plan of laying the superstructure nearly the same as that ordinarily adopted where the heavy rail is used. The iron is of the same weight and dimension as that laid on the first division of the road, viz. an ⌶ rail of 55 pounds per yard. The mud sills were laid, measuring 3 by 9 inches, and varying in lengths of 12, 15, and 20 feet, breaking joints horizontally, on which cross ties placed 3 feet apart support the rail. The ties measuring not less than six inches over the smallest end were only used, and consisted of white oak and chestnut, which were procured on the island. The junction ties were cut to receive the plate into which the rail was received, and securely spiked as also the intermediate ties. The culverts used have been built of wood of a cheap and temporary construction, it being intended to replace them hereafter with rubble masonry.

The third division of the road commences at the termination of the latter, and after passing the range of hills south of Smithtown, at a favorable point, curves to the south about twelve degrees, and pursuing an easterly course for 12 miles after leaving the vicinity of Ronkonkoma pond, passes south of the Bold Hills to Carman's river, about one mile below Hawkins' Mills, when the line deflects about twenty-five degrees to the north on the west side of the river,

curves and crosses the same, and thence pursues a general course to the Manor, 17¾ miles. The topography of this division of the road is much broken by the approach to Carman's river, the descent to which is rapid. The estimate of the cost of this portion of the line for graduation, including wooden culverts, is $64,000 or about $3,600 per mile, but the work having been placed under contracts, on 14 miles of this division at a considerable reduction of the estimate, the terms may be considered very advantageous. The grades on this division are as high as 40 feet per mile. The minimum radius of curvature, 2865 feet. The location of this part of line is equi-distant between Coram and Patchogge, being about three miles from either place. The fourth division commencing at the termination of the latter, on the Manor, continues to pursue the same direction until the line approaches Peconic river within 5 miles, when it deflects to the left a few degrees, and crosses the last named stream about half a mile west of Tuttle's Mills, where it has only a width of 90 feet, after which the line curves to the right, and passing along the margin of the river on the north, enters the village of Riverhead, passing a few rods north of the court-house, continuing on the east of the town, where the line again deflects to the left, crossing the head of Saw Mill Pond, and other tributaries of the bay, curves to the south at Meeting House Creek, and on an east course proceeds direct to Jamesport, the termini of this division of 15 miles. About 6 miles of this portion of the road has been graded in detached sections, but at present is temporally abandoned. The estimate of the graduation including culverts, was about $37,500 or $2,500 per mile. The maximum grade 40 feet. Minimum radius of curvature, 1910 feet.

The 5th and last division of the road has not yet been definitely located; but from the surveys that have been had, sufficient is known to determine the route which will be quite direct from Jamesport, having only one curve after leaving the latter point, and the expense of graduation will not vary from $2500 per mile, as on the 4th division. The grades will not exceed 30 feet per mile, and any radius of curvature can be had. From the above it will be seen that about 44 miles of the road is completed and in daily use, leaving 50 miles of graduation and superstructure yet to be finished, 29 miles of which is contracted for, though only 14 miles is being now worked upon, with an average force of 120 men. Of the whole amount contracted for about 9 miles may be considered as finished, and about 19 miles not under contract.

From Hicksville to Greenport, 68 miles, the line is broken by 10

curves, having a radius in every instance, except one, of 2000 feet, and upwards, and composing an aggregate length of 2 1-2 miles, all of which occur on easy grades, and by equating the latter on the entire line, there exists only a difference of 2 per cent. in the motive effect of trains passing either way. The greatest elevation of the road above tide water is 146 feet, which occurs at Hicksville.

The estimates to complete the graduation, ready to receive the superstructure, amount to the sum of $139,000, to which we will add $11,000 additional for contingencies, and call the aggregate amount $150,000, three-fourths of which amount the contractors are willing to receive in bonds of the company at 4 years; hence there is only required $37,500 in cash to complete the grade of the road. And it is believed the iron can be purchased entirely on the credit of the company. If so, the entire road could be constructed by the expenditure of $100,000 cash, using the bonds of the company only for graduation, iron, and laying of the superstructure in part.

The receipts of this road, which is now only half finished, will not fall short of $70,000 the past year, which is something more than the expenses properly chargeable to the working of the road, renewals, and repairs. On the completion of the road to Greenport, the additional income will no doubt be sufficient to pay all necessary expenses and yield 1 or 2 per cent. upon the cost, and this from the local travel and freight of the island, depending as it does mostly upon the through travel, to afford a fair interest. That the eastern travel will be sufficient for that purpose, very few, if any doubt. On the completion of the road, and judicious management of the same, we may look upon it as likely to become one of the most popular as well as profitable roads in the Union. The economy with which the management of the road is now conducted under its able President, is deserving of all commendation.

E. S.

EXAMINATION OF THE RAILROAD SYSTEM.

No. II.

Having in our last number considered the errors of location on railroads we next proceed to the

Errors in Construction.—But here we must again be allowed to remark that while we are endeavoring to enumerate all the errors

which have occurred during the advancement of the railroad system, we do not wish to be understood as attributing all or any one of these errors to every railroad. Such a hasty generalization would be equally presumptuous and unjust.

The first error in construction which we notice, is improper extravagance. By this we mean an outlay of money by a company not warranted either by the resources, or by their objects--the legitimate business of the road. Under this head, we do not intend to touch upon those points which may be considered as professional questions, and in regard to which engineers themselves are in doubt. The spirit of extravagance so generally prevailed during those years in which the railroad system was developed, that it would be manifestly absurd to attribute to the system itself those errors which may never again coincide with the advancement of railroads. Still as we have in regard to other institutions the means of comparing their condition before, as well as during this period, while the existence of railroads before this time can hardly be asserted—it will not be useless to separate those faults which were peculiar rather to the times than to the system.

We include the charge of extravagance under the head of errors in construction, because it has chiefly affected this department, although the improvident spirit which was peculiar to the times, was rather an error of financial mismanagement. In fact, we might assert that the wasteful expenditure of money upon railroads, was in all cases rather a disregard of details of outlay and a want of attention to those various and often minute items of expense which are so apt to absorb not only the profits, but even the capital of companies as well as of individuals. Probably the most extraordinary cases when properly examined, would show not any *one* item of useless expenditure, but a host of small matters, amounting however to a very serious misappropriation of funds.

The most striking instances of extravagance in construction which can be produced, are those of roads not included in any main line of communication with no prospect of forming part of any such line, and intended to meet the purposes of a purely local and very limited traffic; but constructed upon the model of some of the most important roads in the country, with grades, superstructure, buildings and accessories, equal to the greatest demand upon the greatest thoroughfare. These instances, as far as we have been able to ascertain, are exceedingly few in number, and undertaken either as sheer speculations, or else to carry out and assist extensive and reckless land operations. It is hardly necessary to state

that these railroads have proved utter failures, and have contributed not a little to throw discredit upon the whole system.

We notice too another error in construction, the injudicious use of inclined planes, and stationary power. It is true that the highest professional authorities at one time sanctioned their adoption, but that they were admitted for some time after their inexpediency had been demonstrated, cannot be denied. It is certain that wherever this mode of surmounting heavy grades has been employed, great expense and little profit have been the result.

The use of horse power instead of stationary engines, is open to the same objections, and re-locations to avoid it, show that this is the fact.

Under the same head we might notice the adoption of light grades, which in the infancy of railroads were considered absolutely necessary, to the use of locomotive power. These and similar *experimental errors*, as we might call them, belong to the early stage of railroad history, and although, at the time, they were not in fact errors, yet so rapid has been the progress of improvement, that we are too apt to regard as faulty, what was in accordance with the most correct practice of the day. Several important works were constructed at great expense, upon the supposition of the necessity of exceedingly light grades wherever locomotive power was to be employed.

A third error of construction, and one rather more common than any one yet named, has been the grading of roads for two tracks where one was needed. On all great thoroughfares, and on short roads, two tracks are proper, provided the passage of trains is to be very frequent. But upon lines of great length, one track may always be made to answer, and with proper precautions, it is not unlikely that in all cases two tracks may be avoided by a suitable system of turnouts, and a vigorous discipline. It is a fair question and deserving careful examination, whether the punctuality and systematic management of locomotive power thus introduced would not more than counterbalance the inconvenience which might sometimes occur.

Although but few companies have laid a complete double track, yet very few have been so economical as to grade for but one, and the amount of money thus spent upon extra land and labor, is enormous. Allowing $1000 per mile, for this extra expense, which every one will admit to be a low estimate, and supposing 1000 miles of railroad to have been thus unwisely constructed, the waste will have been one million of dollars. It is gratifying to ob-

serve that this practice of dispensing with the second track is finding favor and will soon generally prevail.

As it is the fault of human nature to pass from one extreme to another, we need not be surprised at finding in our list of *errors* that of *parsimony*. Yet this fault will in some instances be found to have accompanied the opposite one of extravagance. While money has been lavished upon a heavy rail, for example, it is not uncommon to find insufficient fastenings, etc. But pure and unmitigated parsimony in the construction of roads can easily be found—not that we mean by the use of this word, to stigmatise the motive, but simply to describe the fact. A "cheap" railroad is a poor affair. Iron straps a little above hoop iron in size, imperfectly fastened to timbers laid *upon* the ground--embankments with their sides deeply furrowed with gullies which in some cases nearly cross the track—excavations with the sides standing ready for the first heavy rain to wash them into the middle of the road—crazy bridges, stilted over a rapid stream at a fearful height—these are the characteristics of a "cheap" railroad—and we have drawn no fancy picture, but have faithfully adhered to the painful reality, strongly impressed upon us by unpleasant experience.

Much more mischief than is generally imagined, has resulted from false economy in providing insufficient superintendence. On a long line, with but few engines, and few or no responsible superintendents, to assist them, much bad work may be covered up and never come to light until all chance for redress has passed by—and what is worse, at a time when no one else is remembered to be blamed, but the engineer. In masonry such things have frequently happened. It is by no means necessary that fraud should have been intended to produce such results, for carelessness or ignorance may do equal damage and should be equally provided for.

An error in the construction of railroads of no small amount but not generally recognized—is a disregard to the geological character of the site of the road and its general result an improper or insufficient system of drainage. When this fault has been committed, it never fails to show itself in the annual expense of repairs on the road. The effects of frost are greatly increased by an imperfect drainage, while the decay of timber is equally accelerated and the amount per mile per annum consumed in this way alone is a most serious item in the "Maintenance of Way."

A neglect of the peculiar geological formation is in some cases productive of lasting mischief, and cannot be remedied, or only at great expense. A very instructive illustration of this in the ex-

perience of English Engineers, may be found in Mr. Vignoles' lectures.

The following account of the Atmospheric Railway we find in the National Intelligencer.—The extract will be read with great interest by professional men in this country.

ATMOSPHERIC RAILWAY.

Several years ago the public attention was attracted to a proposal for establishing a railway on which carriages were to be propelled by atmospheric pressure. If we remember correctly, some experiments of that nature were tried which completely failed, and it was supposed that the design was abandoned as impracticable. It appears, however, that since that time an atmospheric railway on a small scale has been formed at Wormwood Scrubs, on which experiments have been tried that have satisfied scientific men that the application of the atmosphere as a locomotive power on railways is not only practicable, but would be attended with many advantages over the locomotive engines at present in use. Mr. Pim, the treasurer of the Dublin and Kingston railway, addressed a communication to the Earl of Ripon, the president of the Board of Trade, requesting him to cause an inquiry to be instituted by competent persons to ascertain whether this invention was entitled to a further and more extended trial under suitable superintendence. As any thing connected with the subject of railway travelling must interest the community generally, we doubt not our readers will be gratified by having laid before them some extracts from Mr. Pim's communication, which fully explain the mode of working and the alleged advantages of atmospheric railways:

"It is very generally known," says Mr. Pim, "that several ingenious persons have, from time to time, proposed to employ the pressure of the atmosphere as an element of locomotive power; but their speculations and suggestions were so far removed from practical efficiency that proposals to adopt an atmospheric or pneumatic railway have hitherto been received with contempt or ridicule; indeed, so great has been the prejudice against the principle that very few, even among those most interested in railways, have taken the trouble of investigating what has been accomplished by the very simple and complete apparatus constructed by Messrs. Clegg and Samuda, whose invention has been publicly exhibited on the West London Railway at Wormwood Scrubs for nearly eighteen months past.

"Although the scale upon which these experiments have been tried may be thought scarcely sufficient to arrive at an absolute demonstration by those who only view it superficially, every successive visit has tended to confirm the conviction in the minds of those best qualified to decide, that the invention combines the great essentials of economy, expedition, and, above all, of safety.

"On this system of working railways, the moving power is communicated to the trains by means of a continuous pipe or main, of suitable diameter, laid in the middle of the track, and supported by the same cross sleepers to which the chairs and rails are attached; the internal surface of the pipe being properly prepared by a coating of tallow, a travelling piston made air-tight by leather packing is introduced therein, and is connected to the leading carriage of each train by an iron plate or coulter. In this position, if part of the air be withdrawn from the length of pipe in front of the piston by an air-pump, worked from a stationary engine or by other mechanical means, placed at a suitable distance, a certain amount of pressure on the back of the piston (being the locomotive force) will take place, proportioned to the power employed; in practice, and to work economically, it will be sufficient to produce an exhaustion of air in the pipe equal to causing a pressure from the atmosphere upon or behind the travelling piston of eight pounds per square inch, which is only about one half the pressure due to a vacuum. Supposing the main pipe of 18 inches internal diameter, it will receive a piston of 254 superficial inches area, on which, with the above pressure, a tractive force of 2,032 pounds is consequently obtained; and this is capable of propelling, a train weighing 45 tons (or eight to nine loaded carriages) at the rate of 30 miles an hour, up an acclivity of 1 in 100, or 53 feet per mile.

"The iron coulter being fixed to the travelling piston within the pipe, and also to the leading carriage of the train, connects them together, moving through an aperture formed in the top and along the whole length of the pipe; while one set of vertical rollers attached to the piston rod, at some little distance behind the piston, progressively lift up for the space of a few feet, and another set of rollers attached to the carriage close down again, a portion of a continuous flexible valve or flap, of a peculiar construction, covering the aperture; and it is the very simple, ingenious, and efficient mode of successively opening and closing down and hermetically sealing this valve, as each train advances and moves on, that constitutes the merit of the invention, and the foundation of the patent. The operation consisting, first, in opening the valve to admit the free admission of the external air, to press on the back of the piston and produce motion, and then in effectually closing down and sealing the valve again, so as to leave the pipe in a fit state to receive the travelling piston of the next train, and ready to be again exhausted of its air.

"Stationary engines, of sufficient power, proportioned to the amount of traffic and speed required, would, in practice, be placed at intervals of about three miles apart, and be arranged to work the railway to that length, alternately on either side of their position, as might be required.

"It may be sufficient here to observe that the composition for sealing the valve has stood the effect of exposure to the seasons, and of continued use for nearly eighteen months; that the tallow lining of the pipe produces a smoothness over its interior infinitely cheaper

and probably more effectual, than the most finished boring; and that the connexion of the piston in the pipe with the train will be readily comprehended by any one who will examine a pencil moving in an ordinary pencil case.

"When it becomes necessary to stop or retard the carriages, in addition to the use of a common break, a valve in the travelling piston may be opened by the guard or conductor of the train, whereby the external air being admitted in advance of the piston into the exhausted portion of the pipe, the propelling power is at once destroyed.

"The separating valves in the main or pipe between each section or division of the line being made self-acting, there will be no occasion for stopping or even retarding the movement of the train, in passing from one division of the pipe to another, as the air is successively exhausted by the stationary power placed at the proper intervals. The carriages may, therefore, pass continuously, at any required velocity, as if drawn by a locomotive engine; and it is necessary to keep this circumstance in mind, as, by any other system of traction by stationary engines than the atmospheric, a stoppage and a charge at each engine is unavoidable.

"The great feature of the modern system of railway traction is this locomotive steam engine; and nothing is, perhaps, better calculated to demonstrate the mechanical genius of the country than the successive improvements which have been applied in the details of its construction. While our engineers have gradually ventured to lay out railways deviating greatly from the truly horizontal lines, originally considered nearly indispensable, and have increased the velocity of the trains to an extent almost alarming, the skill of the mechanist has kept pace with the necessity of finding powers to do the duty required; and, by dint of strict regulation of expenditure and various minor improvements, the cost of locomotive power has certainly decreased, when calculated upon a mere mileage of the trains. But, as the gradients of railways have been made steep, and as the rate of travelling has been augmented, the engines have of necessity, been made of greater power and weight, and additional sources of danger created by the introduction of assistant locomotives to surmount inclines or to keep up high speeds, and by the necessary increased momentum of the trains.

"With all the recent improvements and saving in the cost of locomotive power, the wear and tear, as compared with stationary power, is, however, fully 20 to 1, as may be exemplified in many instances of stationary engines working 10 or 12 years without any material repairs, and scarcely without stopping, and contrasting this with the costly establishments and constant expenditure incurred, even on short lines of railway, in keeping up locomotive engines to their effective performances.

"In addition to the causes of damage and expense from the use of this travelling power, there are the delays incident to the slipping of the engine-wheels from the want of adhesion when the trains are heavy, or the gradient steep, or the rails 'greasy' from

slight rain, or glazed by fog or hoar frost, and again by the freezing of the pumps in severe wintry weather; each of which causes of delay becomes an additional source of danger, from which repeated and serious accidents, attended with fatal results, have happened. Although the occurrence of the pumps freezing is not frequent in this country, yet in many parts of northern Europe and America it must almost act as a total stoppage to railway traffic with locomotive engines in the depth of winter. The variation in the rate of travelling, from the varying velocities of trains drawn by locomotive engines, is likewise a cause from which accidents occur; and yet these different rates of speed can scarcely be avoided, as third class passengers and luggage, to be economically transported, must necessarily go by slower trains.

"To these various disadvantages in working with locomotive power may be added the necessity of using coke almost exclusively, which, in remote districts particularly, adds enormously to the expense. Fixed engines, consuming coal or turf (and, on the continent of Europe and in America, wood) as the case may be, will give out steam-power at a greatly less cost than locomotives can do under the most favorable circumstances. But, besides the wear and tear of the locomotive engine, and its injurious effects on the railway, there are some other striking disadvantages connected with it: a very considerable proportion of its power is manifestly absorbed in moving its own weight and that of its tender; while it is equally obvious that the faster it travels and the further the gradient deviates from a horizontal line, the more power is thus absorbed; but few persons are aware that this loss takes place in a rapidly increasing proportion, not only arising from the causes I have [illegible]ted, but from others which are inherent in the construction of the machine; so much so, that it is stated by Mr. Wood, in the last edition of his work on railways, that, under ordinary circumstances, increasing the velocity of a train from 25 to 30 miles per hour is attended with a loss of more than half the effective power of the engine. A similar loss is sustained if the locomotive has to draw its load up an incline scarcely perceptible to the unpractised eye; and should this inclination be increased to 1 in 100, the effect is reduced to about one-fourth of that produced on a horizontal plane at the previous velocity, the power being lost or absorbed in the inverse ratio in which it requires to be augmented, precisely at the moment when it is most important to obtain an increase. This subject has been ably treated in the Second Report of the Irish Railway Commissioners (see notes D and E, pp. 104 to 110, which are understood to be from the pen of Professor Barlow.) It is there shown that 'the power thus absorbed, in what may be termed the preparation for motion, with first-class locomotives, is 1,075 lbs. which is sufficient to draw more than 14 tons on a good road by horse power,' 'and on a canal, with the usual barges,' 'more than 190 tons,' and that 'this absorbed power is nearly one-third of the whole power of the engine.' Now, the great advantage of the atmospheric system will be to obviate the waste of power, and con-

sequent absorption of profits, arising from transporting useless weight and overcoming unnecessary friction, which it is hopeless to succeed in effecting by any other known mechanical means; for as it is proposed to work on this system, there will be nearly obtained a corresponding dynamic effect for the amount of power generated, whatever it may be; whilst, by the present system, as I have already shown, there is an enormous absorption of power by the locomotive, whether moving at high rates of velocity, or up any material acclivities.

"It is manifest that on railways intended to be worked by atmospheric power, there is not at all the same necessity for having 'good gradients' as on those now at work; and wherever it may be necessary to adopt rather steep inclines for some short distance, it can easily be accomplished by increasing, at the place of difficulty, the dimensions of the apparatus and the amount of mechanical power.

"The economical advantages of the atmospheric system will be further exemplified in the diminution of the expense of maintenance. The destructive action of the locomotive engine (seldom, with its compliment of water and fuel, of less weight than fifteen, and often nearer to twenty tons) no longer impinging on the rails, a comparatively small sum will keep the line in repair; and though it may be difficult beforehand to assign the exact proportion of saving, it is evident the amount must be very considerable.

"In the carrying department the whole of the water stations, repairing shops, and fittings up necessary for the locomotive engines, are at once dispensed with, and the coverings and general arrangements of all stations much diminished in cost; heavy turnplates may be wholly done away with, and even the smaller ones, except at the termini of great lines, as the carriages can move in either direction; every description of carriage, having no longer to sustain the shock and tug of the locomotive, may be made very much lighter and cheaper, and built to carry a greater useful load both of goods and passengers in proportion to the weight than is the case at present, and will last considerably longer.

"The rate of travelling by the atmospheric railway will depend on the rate at which the air in front of the piston may continue to be pumped out by the engine, a sufficient degree of exhaustion having been previously obtained to move the load at the required velocity; and I see no reason to doubt that a speed of sixty miles per hour may be easily, economically, and safely obtained by this means; and in addition the passengers will be relieved from the noise, smell, dust, sparks, and hot cinders from the locomotive engine.

"A moment's inspection of the apparatus, or a little consideration of the description, will be sufficient to produce the conviction that the pressure of the atmosphere cannot move two trains at the same time in opposite directions between any two stationary engines, and thus collision becomes impossible on the atmospheric railway. It is equally obvious that one train cannot overtake another, and the

leading carriage of each train being firmly attached to the piston-rod, it is scarcely possible that a carriage can be driven off the rails. Thus the ordinary sources of railway accidents appear to me to be removed, and the apprehension of danger, now unfortunately so general, would soon naturally subside on the introduction of this principle into practice.

"It becomes manifest, from the preceding statements, that, by the proposed means single lines of railway may be worked with perfect safety. There are but few districts of country through which, by starting trains with sufficient frequency, a single line of railway would not be adequate for all their present or prospective traffic, even with the use of locomotive engines; but single lines cannot be worked by these machines without incurring that risk of collision which will render the practice highly objectionable, and will always prevent the use of such lines to their full extent or capabilities.

"The atmospheric principle is free from this objection, and single lines can be worked thereby fully and effectively. Trains may be despatched from each end of any line in opposite directions, as frequently as the traffic may demand, without the possibility of coming into collision; as it has been already shown that no trains in motion can possibly approach nearer to each other than one section of the main pipe, being at the least three miles. Sidings would of course be provided at every station.

"With stationary engines placed at intervals of say three miles, there may be at those distances, under judicious management, a large amount of spare power to be employed for many useful purposes. At times between the passing of the trains, when the engine would not be required to work the air-pump in exhausting the pipe, it might grind oats or wheat, saw wood or stone, pump water drain lands in one part or irrigate them in another, thus performing various mechanical or agricultural operations. In suitable situations a smaller engine might be continually employed, in lieu of the larger one, in raising water to a proper reservoir, where it would be always ready and available as the trains might arrive, being equally applicable as steam to work the air-pump. All the contrivances for the economic generation and use of steam, such as clothing the boiler and working by expansion, are available to the fullest extent with the stationary engine, which is not the case with the locomotive. In some places the natural supplies of water might even be accumulated in sufficient quantity to dispense with the steam-engine altogether.

"What the ultimate result would be of having a large amount of steam power, which may be hired out on most reasonable terms for various useful purposes, spread over the face of the country at intervals of three miles, and having a railway communication with each of them, I shall not now stop to inquire; but I submit it as an interesting and peculiar feature of the proposed plan, and one eminently deserving your lordship's attention.

"As it is practicable by the introduction of the atmospheric sys-

tem to reduce the cost of constructing, maintaining, and working railways so materially, a corresponding reduction in the charges for transmission of goods and passengers will follow; if, in addition, we are enabled to carry passengers at considerably greater speed and with much greater comfort, and, above all, if we are able to remove the apprehension of personal danger, who is there bold enough to assign the limit to the advantages of railway intercourse by this means?"

On the receipt of Mr. Pim's communication, the Earl of Ripon considered the subject of sufficient importance to induce him to refer it to Lieutenant Colonel Frederic Smith, of the Royal Engineers, and Professor Barlow, with directions that they should inquire into the application of the atmospheric principle in producing locomotion on railways. Sir F. Smith and Professor Barlow prosecuted the inquiry thus delegated to them, and the results of their investigation are summarily stated in the following declarations, with which they conclude their report on the subject:

"Firstly. That we consider the principle of atmospheric propulsion to be established, and that the economy of working increases with the length and diameter of the tube.

"Secondly. That the expense of the formation of the line in cuttings, embankments, bridges, tunnels, and rails will be very little less than for equal lengths of a railway to be worked by locomotive engines, but that the total cost of the works will be much greater, owing to the expense of providing and laying the atmospheric tube, and erecting the stationary engines.

"Thirdly. That the expense of working a line on this principle, on which trains are frequently passing, will be less than working by locomotive engines, and that the saving thus effected will in some cases more than compensate for the additional outlay; but it will be the reverse on the lines of unfrequent trains. However, there are many items of expense of which we have no knowledge and can form no opinion, such as the wear and tear of pistons, valves, etc. On these further experience is needed.

"Fourthly. That with proper means of disengaging the train from the piston, in cases of emergency, we consider this principle, as regards safety, equal to that appertaining to rope machinery. There appear, however, some practical difficulties in regard to junctions, crossings, sidings, and stoppages at road stations, which may make this system of less general application.

"We may add that the atmospheric principle seems to us well suited for such a line as the projected extension for Kingstown to Dalkey is represented to be, but we should have been glad if this line had been three miles instead of only one mile and three quarters in length, as it would have then brought this principle to a more complete and decided test."

"*On the Construction of the Bridges on the Bolton and Preston Railway.*" By A. J. Adie.

This paper which was written at the request of General Pasley, and by him communicated to the Institution, contains a description of the bridges over the Cowlin Brook, the Lancaster Canal, and the Chorley Road, which alone possess any peculiarities of construction, and they formed the types upon which the other bridges were built.

In Colonel Sir F. Smith's report upon the Cowlin Brook bridge, he advised great attention being paid to the bridge on account of its "unusual slightness, and the badness of the ground upon which it was founded." The author states, that the latter circumstance induced him to design the present proportions of the work as he wished to reduce the weight of the piers as much as possible; he therefore ventured to deviate from the original design given by Mr. Rastrick. The result has justified his anticipations, as "after the most careful inspection not a single crack nor a splintered stone can be detected."

The ground where this bridge was to be placed, was found to be a rotten and compressible mixture of moss, decayed wood, and sand, with a few large stones; a foundation was made for each pier by driving in piles 20 feet long by 12 inches square; upon these were placed the footing courses of Limerick stone 8 inches thick; the piers were built hollow, so that the utmost weight placed upon each superficial foot should not exceed $5\frac{1}{2}$ tons, which the author states to be a light load for ashlar work:—"In Edinburgh there are old rubble walls 34 inches thick and above 100 feet high, which in addition to all their proportion of eight floors, and a roof, have $6\frac{1}{4}$ tons on each superficial foot of the bottom courses, and there is a brick chimney in Bolton, the bottom courses of which support $8\frac{1}{2}$ tons on the superficial foot."

The bridge consists of eight arches, each of 30 feet span; the arch stones are 18 inches thick, of hard sandstone from the Whittle hills, except seven courses at the crown, which are from a better quarry at Ackrington, near Blackburn.

The author then mentions, as a precedent for such dimensions, some arches constructed under Mr. Jardine's direction on the Edinburgh and Dalkeith Railway; they were of Craigleith stone, semi-elliptical in form, of 24 feet span, with a rise of 4 feet., or $\frac{1}{6}$th of the span; the stones for these arches were 12 inches deep at the springing, and 9 inches deep at the crown; the abutments of one of them are founded on platforms of timber, without piles, resting upon soft plastic blue clay; they have been standing for upwards of ten years, and exhibit no signs of failure. Another arch is also mentioned, constructed by the same engineer, over the South Esk, near Dalkeith, the span of which is 55 feet, and the versed sine 12 feet; the keystone is 18 inches deep, and the springers 21 inches in depth.

The author objects to placing a mass of earth upon the haunches

of the arch, as, from the tremour caused by the passing of the railway trains, the earth has always a tendency to be wedged in between the side walls and to force them out; he therefore left voids above the arch stones, allowing only sufficient weight of masonry upon the haunches, and thus securing the rapid hardening of the mortar; for this latter reason also the walls of rubble-work never much exceed 3 feet in thickness, and they have been found much stronger in consequence.

The railway is carried over this viaduct on longitudinal bearers, 13 inches deep by 6 inches thick, laid on planks 3 inches thick; the bearers and planks are not fixed together with a view to diminish the vibration of the passing trains; this method of laying is stated to be very effective in this respect.

The Lancaster Canal Bridge was originally intended to have been a direct span of 60 feet, constructed of iron, but the directors subsequently decided on building a skewed stone arch of 25 feet span on the right angle. The arch is semi-elliptical on the square, with a transverse axis of 41 feet 2 inches and a semi-conjugate axis of 8 feet 9 inches; the arch stones are 2 feet 3 inches on the square at the springing, and 1 foot 6 inches at the key-stone; the bed joints intersect at right angles all the lines of sections of the intrados, made by vertical planes, parallel to the elevation; and it is that property that causes the chamfer lines of the beds of the stones to diverge from the springing to the crown. These lines of the curved joints are easily laid down on the sheeting of the centres from a full-sized development, and by lines drawn at different heights, parallel to the springing of the arch. The lines of the radiating bed joints are always perpendicular to the tangent of an ellipse of the same form as the elevation of the bridge, the moulds used to form this being applied in the plane of the elevation. The twist on the length of the beds of the courses was taken from full-sized skeleton moulds of the form of the oblique ellipse or elevation. The five courses running parallel to the abutments are all of the same form and have the same amount of twist on the beds of each stone, except the end stones of the courses, which are varied in length to suit the general breaking of the joints of the courses resting together. The centre part of the arch is plain square work.

This mechanical method of finding the lines, and the twist of the radiating beds for an elliptical skewed arch, is destitute of the scientific accuracy of the mode by which Mr. Buck calculates his spiral lines for oblique bridges, of which the section at right angels to the abutment is an arc of a circle; but the workmen had no difficulty in putting it in practice, and the author states that he would have had more trouble in constructing trussed centres for a flatter curve of a circular arc, and at the same time keeping the towing path of the canal open. He states that he has not met with any description of an arch executed in this manner, but he considers it the only true principle. Every very thin section parallel to the elevation is a proper elliptical arch, and there is a very great saving of stone from the smallness of the twist on the curved beds as compared to the common method of working them.

The Chorley Road Bridge is a compound of the common and skewed arches, which the author finds convenient and economical. He has executed several upon this plan; they are as perfect as the best common arches, and free from skirting of the soffits of the stones. The section of this bridge at right angles shows a rise of 5 feet, with a span of 25 feet. The springers at this part are 15 inches deep, and the key-stone is 13 inches deep; on the oblique section, or the elevation, the span is 37 feet 9 inches, and the rise 5 feet; the springers are 24 inches deep, and the key-stone is 17 inches deep.

The straight part of the arch is formed with courses about 10 inches on the soffit, and these are turned round in curved lines which are portions of circles, the straight parts of the courses being then tangents, and they cut the lines of the elevations at right angles, so that there is no more tendency of the arch to sink at the elevation than would be the case with any elliptical segment of similar dimensions worked in the ordinary way. The part of the acute angle of the arch is formed with courses which converge from the elevation to the abutments, on account of being arcs cutting the elevations at right angels, and then becoming nearly tangential at the springing. The curves for these courses were transferred from the development to the sheeting, in the same way as those for the Lancaster Canal Bridge, and the twist of the beds was taken off full-sized sections of the arch, made in the directions of the converging lines of the extremities, so that at each of these places the beds were worked as if for part of a true elliptical arch, and the beds between the points thus formed were worked off with curved rules found from the development. After the masons got into the way of working this kind of arch, they of their own accord preferred it to the complete skewed arch. In brick work built in this way, it would be very easy to skew the ends of a long archway by having the bricks moulded to the curvature of the key-course, as with a very little alteration they would fit any part of the concentric courses and a few tapered bricks would facilitate the filling up of the fan-shaped part of the haunch of the acute angle.

The communication was illustrated by several detailed drawings and a model of the bridge, with schedules of the prices and cost of the works.

EXTRACT FROM THE REPORT OF THE SECRETARY OF WAR.

The report of the Colonel of Topographical Engineers affords new and continued evidence of the great usefulness of that corps, and of the zeal and ability of its officers. An accurate knowledge of the topography of our very extended territory, particularly of its maritime and internal frontiers, of its lakes and rivers, of the obstructions to intercommunication, and of the positions most required and most capable of densive works, is indispensable alike to intelligent legislation and to efficient executive administration. As

a mere question of economy, such information can scarcely be acquired at too high a price. The advantage of an organized scientific corps, qualified by study and practice for this peculiar duty, over the irregular services of persons transiently employed, without organization, and without the opportunities of mature and systematic deliberation, doubtless dictated the formation of this corps; and all our experience has shown the wisdom of the measure. The reports in detail of the several officers of the corps, appended to that of the Colonel, present a mass of the most valuable information respecting the topography of various parts of the Union, from the remote North to the extreme South. They exhibit the progress made in the surveys, in the improvement of harbors and rivers, in the construction of light-houses and breakwaters, and in various other works in charge of the corps. A brief notice of a few of those which seem to require attention is all that will be attempted on the present occasion.

It will be perceived that considerable progress has been made in the survey of the North-western lakes, and that preparations for its continuance the next season have been made, which will enable those in charge of the work to accomplish more than was practicable during the last year. The expense of these surveys is comparatively so trifling that they can scarcely be liable to objection in almost any state of the Treasury. I cannot omit to call attention to the report of Captain Williams, respecting the urgent necessity of a harbor on the west side of Lake Michigan, and the improvement of the navigation at the mouth of St. Clair river. These are exceedingly important to the United States, to enable us to furnish supplies to the Indian tribes, and military stores and subsistence for the troops which, even in time of peace, must be maintained in that quarter, and which, in the event of hostilities, will afford the only barrier between savage ferocity and our frontier settlements. But to our fellow-citizens of that region, who have purchased the public lands, a safe access to the markets of the East is so essential as to justify their calls upon the Government for a common share of its protection. The commerce of the lakes, comprising the production of seven States and one Territory, which must annually exceed twenty-five millions of dollars, would seem entitled to consideration and assistance, not only on account of the great interests involved in its success, but on the ground also of a fair apportionment of the fostering and protecting aid of the Government. This commerce affords the only effective means of supplying the nation with the mariners who will be found indispensable in that quarter in the event of hostilities.

It will be seen that the surveys for the defences of Sollers's flats and of Delaware breakwater harbor are completed: those for the defences of Sandy Hook, and the harbor and town of Portsmouth, New Hampshire, are in execution, as well as the military reconnoissance of the peninsula of Maryland, south of this city. It is gratifying to learn that an extensive and very thorough reconnoissance of the defences of New Orleans, embracing a large extent of territory, has been completed.

The raft which formed the obstruction to the navigation at Red river has been removed—an event of no small importance to our fellow-citizens in that quarter.

The Potomac aqueduct is so far completed as to warrant the confident expectation that it will be in a condition to receive water in the course of the next season. The repairs of the Potomac bridge are drawing to a close, and it is belived that it will be passable in January next.

The measures taken to execute the law of the last session, appropriating one hundred thousand dollars for the improvement of the Ohio, Mississippi, Missouri and Arkansas rivers, are also stated. So soon as the application for an injunction by Henry M. Shreve, Esq. which has arrested the progress of those measures, shall be disposed of, they will be resumed. But it is manifest that the present appropriation is wholly inadequate; that it can only provide the necessary snag boats; and that, unless followed by others, the expenditure of the money will be but to waste it.

The proceedings of the corps under the laws respecting the construction of the light-houses, are also detailed in the report. It would seem that the expense of these invaluable auxiliaries to commerce may be much diminished by the adoption of Mitchell's patent screw moorings, a recent English invention; and that by means of such moorings they can be placed in positions far more advantageous to the mariner than any that can be occupied in the present mode of building them. The sanction of Congress is invited to the the steps recommended by the Colonel of Topographical Engineers to procure the necessary apparatus, and acquire a knowledge of its application.

It will be seen that a party of engineers is in the field for the survey of the Arkansas and Platte rivers and the adjacent country. A survey of the country north of the Missouri having been completed, the map of which, constructed by Mr. Nicollet, unequalled in the accuracy and fulness of its details, is now nearly finished, and will be published in January next. It is intended to cause a similar survey of the country south of that river, embracing the approaches to Rockey Mountains, their several passes, and gradually the region between them and our possessions on the Pacific. These explorations and surveys are indispensable to such a knowledge of the country, its resources and its streams, as we must possess before we can establish any communication with a region that is every day becoming more important to us; and it is hoped that there will be no reluctance to granting the very moderate appropriations asked for the continuance of the "military and geographical surveys west of the Mississippi river."

Practical detals of Management are always useful. The following notes from "The Civil Engineer and Architects Journal," seem to contain some good hints.

NOTES ON STEAM NAVIGATION.

The management of the furnaces.—It is a common practice in steam vessels to pile the coal much too abundantly on the fire grate, the stratum of incandescent fuel is too thick, and the generation of carbonic oxide is the consequence, to the manifest diminution of calorific effect. The coals should be strewn upon the grate bars evenly and equally; the depth of the stratum should be about three inches, but this is a point dependent in a great measure upon the intensity of the draught; the stronger the draught the thicker should be the stratum of incandescent fuel. The bars should never exceed 7 feet in length, and should be as much less as possible; 5 feet is a good length, and not an uncommon length in the best boilers, It is impossible to fire long furnaces properly, especially in a sea way. We have known the length of the fire bars to be reduced from 8 ft. 6 in. to 5 ft. 6 in., with a great accession to the steam-producing powers of the boiler. The bars should always have a considerable inclination, both to facilitate the transmission of the fuel from their foremost to the aftermost extremity, and to diffuse the air more equably over their lower surface. The skill of firemen varies greatly, and due attention should be paid to their selection. A dead plate at the mouth of the furnace is a good thing, and combined with a slow combustion will obviate smoke and save fuel. These are the true secrets of combustion on chemical principles.

Boilers, wear and tear.—The wear of boilers is not unfrequently chiefly from the outside round the steam chest, from the dripping of water from the decks, in the ash pits from the wetting of the ashes, and on the bottom of the boiler from the action of the bilge water. This last source of wear is now almost altogether obviated in some of the best steam vessels, by placing the boiler upon an efficient *caulked* platform, bedding it in putty—not an incorporated mass of lime and oil, but really sound substantial putty, such exactly as glaziers use. A cooming of timber is attached to this platform, encircling each boiler, and the interstices between the timber of the cooming and the iron of the boiler are filled in with roman cement, and sloped off on the upper side, so that no water can lie on the cement or cooming. It might be expected that these coomings would be disturbed by the expansion of the boiler when heated, but we find that the expansion is so inappreciable in practice as not to be productive of any visible derangement. The upper parts of boilers should be covered with felt and sheet lead, soldered wherever there is a joining; the practice of covering boilers with felt and sheet lead is now almost universal among the best engineers.

Blow-off cocks are a perpetual source of annoyance if they be not well made at first. The metal of which they are composed should be hard and tough, without any lead in it. The plugs of the cocks, if made with too little taper, will be very apt to jam, and after having been ground a few times, will sink so far into the

socket as to come in contact with the bottom, if there be one, and diminish materially the effective area of the water way. If the taper be too little on the other hand, a great strain will be thrown on the gland, which keeps the plug in its place, and if they give way it will be driven out with great force. This did occur in the Great Western, and the engineer was scalded to death.

The durability of brasses is dependent upon a variety of circumstances, but chiefly upon the quantity of rubbing surface and the quality of the metal. We have seen a brass of Boulton & Watt's which had worked for thirty years, and was at the end of that time in good preservation, whilst we have seen other brasses which, in the course of a couple of years, were quite worn out.

De omnibus rebus et quibusdam aliis.—Should the engineers be subject to the captains? In generals, YES—in particulars, NO. The Admiralty regulations in reference to engineers are just as preposterous as might be expected, inasmuch as the Admiralty is invariably a century behind the merchant service, but in their regulations respecting engineers, they have out-Admiraltied themselves and earned a title to a squabash with our tomahawk, with which we may probably honor them on an early occasion. The Admiralty desires to have young men of education as engineers, and yet with Admiralty consistency rates the engineer *beneath* the ship's carpenter—and what engineer of talent and education would place himself in so abject a situation, or submit to be snubbed and browbeaten by every whiffling lieutenant or embryo midshipman who does not know the garboard streak from the log line? As to your amateur mechanics, we always shun them as carefully as we would do a rabid dog; their bite is dangerous, and their bark—why that of Cerberus was heavenly music to it. We have never recovered from the alarm we once experienced from the spectacle of one of these *cognescenti* with blackened fustians and white kid gloves, crawling daily for the space of a whole week, through the labarynths of an oily steam engine, to vindicate his title to engineering proficiency. We bethought ourselves of Nebuchadnezzar, and betook ourselves out of reach of the saliva. When we take upon ourselves the administration of the Admiralty, which, between this and 1942, we may perhaps be prevailed upon to do, our first operation will be to get a leviathan besom constructed to sweep away all such incurables, preparatory to placing engineers in their proper position.

Ventilation is a thing greatly neglected in steam vessels, although so many facilities exist for establishing an effectual system. Every vessel should be fitted with one or more fans, or Day's patent Archimedean Screw ventilator, worked by the engine for exhausting the air from the different cabins, gratings being left above the doors and other suitable places for the admission of fresh air from without. The same mechanism might be made to draw air from the holds and other parts of the ship, so that any bad smell from bilge water, etc, would be entirely obviated. In tropical climates, in particular, no steam vessel of any considerable size ought to be unprovided with a ventilating apparatus.

The rolling of steam vessels in a sea way gives a lateral impulse to several parts of the machinery, which it is often not well calculated to resist, without a considerable jolting. Thus the side levers will, when the vessel rolls heavily, slip in and out upon the main centres, and the shafts will move endways. It is true there are collars to prevent this, and in new engines no great movement of this kind can take place; but the collars are in most cases much too small—they are deficient in rubbing surface, and they consequently wear, in a short time, considerably into the brass, leaving a lateral play upon the journal, which admits of no adjustment. To obviate this evil, Messrs. Maudslays & Co. are in the habit of making their journals with very large fillets in the corners, so as, in fact, to make each end of the journal a short frustrum of a cone. This has the desired effect, but occasions a wasteful expenditure of the oil. Mr. Robert Napier makes his cranks to bear against the flanges of his brasses. This plan obviates the rapid wear, but still leaves any wear that has taken place unsusceptible of re-adjustment. The best plan, it appears to us, would be to make each journal bulge out in the middle, so as to constitute, in fact, a portion of a spheroid, and recess each brass correspondingly. The act of tightening the top screws of the journal would then have the effect of preventing the shafts from moving on end, as well as of preventing them from moving up and down. The outer bearing of the paddle shaft should be always so made as to admit of easy adjustment. A common plummer block with the top constructed for holding tallow, placed upon a good stout carriage bolted to the fore and aft bearers, is, in our judgment, the best arrangement. The plummer block bolts should be so made that they may be dropped down to admit a piece of plate iron between the sole and the carriage at any time the shafts may require re-adjustment. A brass in the upper part of the plummer block at the outer end of the shaft is unnecessary, as there is no upward strain, and the cover bolts should be merely sufficient for holding it on in a sea way. This journal always wears forwards as well as downwards, and the brass should be so made as to admit of the aftermost side being turned before. The sides of the brass should also be thicker than in journals where this action does not exist.

Piston Rods.—The best mode of attaching the piston rod to the cross head is by means of a cone and cutter and gib, and a screw above the cone; this cone should have considerable taper both to obviate any injurious expanding action which a cone of little taper would occasion, and to facilitate the disengagement of the rod when it requires to be taken out. Some of Boulton and Watt's cross heads are made close over the piston rod, except that a little hole is left in the top to admit the introduction of a drift to start the piston rod when it requires to be disengaged. This we think is a very objectionable plan, and we have known it in practice to be productive of the most serious inconvenience; for a small drift will not start a rod on which the taper is not considerable, and which is rusted into its place. The drift may indeed be

assisted by a cutter driven into the cutter hole, and so contrived as to force the rod down instead of keeping it up; but even with this aid we have known the largest drift that could be introduced through the top hole to be quite ineffectual in starting the rod. It is a bad practice too to make the upper part of the rod that fits in the cross head eye parallel; a blow or two upon this parallel part will stand and swell it so as to rivet the rod into the socket.

Iron Ships have been much cried up of late by iron ship builders. We admit their claims to favorable consideration, but at the same time maintain that they are attended by many serious disadvantages. In the first place the accumulation of seaweeds and barnacles is a formidable objection. We have seen indeed a scheme of a scraper for removing these accumulations whilst the vessel was under weigh, but it is in our mind puerile and impracticable. Again, the iron of which vessels is composed has been found to become brittle in the course of years, so that although tough at first, it will in the course of time star like glass when struck by a hard and sharp body. The action appears analagous to that which takes place in railway axles. Mr. Nasmyth, indeed, has shown that railway axles are rendered brittle by cold hammering, and may be toughened again by annealing; but he has not shown that axles are not rendered brittle also by continued wear, or that this species of brittleness admits of the same remedy.

Bilge pipes are best of lead, both because lead resists the action of the bilge water better than any other metal and because it is much cheaper than copper. But the blow off pipes should never be of lead; lead blow off pipes bulge and burst from the continued heat and fragrance to which they are subjected. We find that Mr. P. Taylor at the Institution of Civil Engineers, a short time ago recommended all the pipes exposed to the action of the bilge water in any measure to be of lead, and his recommendation was allowed to pass without comment. We therefore think it expedient to say that we altogether differ from Mr. Taylor in this particular. Neither the blow off or deck pump pipes should ever be of lead though they are always more or less exposed to the action of the bilge water. No engineer in this country ever thinks of making blow off, deck pump, or injection pipes, of any thing but copper.

Waste Steam Pipe should be as high as the funnel, especially if situated before the funnel. When the waste steam pipe is shorter than the funnel, the action of the steam on the iron of the funnel rapidly oxidizes it and speedily makes the funnel very thin in that part of the ascent to the mouth of the waste steam pipe. When the pipe is made as taunt as the funnel, the steam is carried clear of the funnel altogether.

Stop valves between the boilers should be permitted always to act of their own accord, and should never be opened and kept open by drawing up the spindle and keeping it up. Unless the stop valves be allowed to act spontaneously like the safety valves, they will soon become so fixed by corrosion that they cannot be shut at all,

and are consequently of no avail. If the increased pressure incident to the weight of the valve be objected to, that weight may easily be balanced by a weight and lever attached to the spindle, where it emerges from the stuffing box of the valve box cover.

Rudder.—It is a judicious practice to make the rudder rather shorter than is requisite to reach the keel—the rudder will thus be unaffected if the vessel takes the ground. The keel should always project a little beyond the rudder joint so as to prevent warps or ropes of any kind from catching in the joint as the vessel passes over them. The rule joint is the best species of joint for a steam packet rudder, and by far the neatest: the rudder head should be round and should fit accurately in the rudder trunk, which of course should be a cylinder.

Paddle box boats of Capt. Smith are we think inconvenient—unsightly and ineligible. It would be greatly preferable to have a dozen boats stowed inside one another like the nests of pill boxes of the apothecary. In a heavy sea the paddle box boats could not be raised without great difficulty, and when raised could scarcely be approached. Their proximity to the paddle when launched is dangerous, and the waves would fly up through the paddle box in a sea way with great force, and cut off all communication between the boat and the ship. We regret that Capt. Smith has not found a better vehicle for his ingenuity than this cumbrous, ineffectual and unsailorlike contrivance.

GEOLOGY OF SOILS.

1. Agricultural chemistry aims to explain all the actions of earth, air, and water, upon plants. It refers to all their chemical relations, to the geology, minerology and chemistry of soil.

2. Agricultural geology explains the relations which soil bears to plants, and the manner in which that affects vegetation.

3. Agricultural geology confines itself to facts. It digs into the earth, observes what composes that; how its components act upon plants. Conversant only with facts, or logical deductions from these, it leaves to geology proper, the vast mass of observations, supported by the highest modern science, which teaches the origin, mode of formation, original condition, and successive changes which our globe has undergone.

4. The terms, primitive and secondary, used by geologists, are almost parts of common language; yet, need to be explained to the farmer.

5. A large tract of any extensive country is composed of rocks of a granite texture. This needs no definition. Such rocks having been observed to underlay all others, in the scale of rocks composing the earth's crust, were called primary. It was supposed that these were first formed. Out of the ruins of these, no matter when or how ruined, other rocks have been made, called secondary. The ruins of the primitive rocks have been transported by

water, and then gradually deposited layer upon layer. Under immense pressure, these layers of mud, sand, fine gravel, rolled stones, etc., have been, hardened into solid rock; forming sandstones, slates, or even rocks presenting the crystalline structure, or texture of granite, by the action of heat, which the facts of modern geology teach, exists in the interior of our globe.

6. This central heat is supposed to be the case of volcanoes, and the primitive rocks themselves, to have been the ejection, under circumstances unknown, of the melted mass of the globe; ejections, similar in kind, to those of modern lava, but greater in degree.

7. Intermediate between modern lava, and primitive rocks, and actually passing into either, is a large class of ancient volcanic rocks, called, trappean; such are basalt, trap, and highly crystalline porphyry.

8. However named and classed are the rocks of the earth's surface, they have one common origin, the molton matter of the globe. Hence, having a common origin, their ultimate chemical constituents are similar. If granitic rocks have a certain chemical constitution, then sandstone, slate, etc., having been formed from worn out and worn down granitic rocks, have a constitution chemically like them.

9. To the agriculturist, the terms *primary* and *secondary*, are useless. Equally so are all distinctions of soil based on these terms.

10. Soil is the loose material covering rocks, and often is included in that term. Both are to be classed by their origin. The origin of rocks refers not only to the mode of their first formation, but to their subsequent arrangement. The origin of all rocks, geology teaches, is from the molton matter of the globe. These have been, afterwards, in some cases, removed by water, and in part remodified by heat [5]. Referring rocks to their origin, they are divisible into two great classes.

1st. Those formed by fire.

2d. Those formed by water.

11. This division relates both to the origin and distribution. In their origin all rocks are truly *igneous* or by fire. In their distribution they are *aqueous* or by water. This is the only division necessary to the farmer. It is the division taught and demanded by Agricultural Geology.

12. The first class includes all the highly crystalline rocks, granite, gneiss, sienite, greenstone, porphyry; basalt, lava, volcanic sand. The products of volcanoes, whether ancient or modern, agricultural geology places in the same class, including thus all that portion which forms the largest part of the earth's surface.

13. The second class includes sand, clay, gravel, rounded and rolled stones of all sizes, puddingstone, conglomerates, sandstones, slates. When these various substances are examined, a large part of sand is found to be composed essentially of the ingredients of the igneous rocks. This is true also, of sandstone, slate, of conglomerates, of bowlders.

14. There is a large deposit, or formation in some districts, composed almost wholly of one of the chemical constituents of the igneous rocks, united to air. The constituent is lime, the air is carbonic acid, forming by their union carbonate of lime. Marble, limestone, chalk, belong to this formation. These are not to be ranked as original igneous products, subsequently distributed by water. The lime, originally a part of igneous rocks—has been separated and combined with air, by animals or plants, by a living process, called secretion. The modern production of carbonate of lime, is still going on under the forms of shells and corals. Though belonging to neither division, the subject will be simplified by referring limestone to the second class of rocks—but it is truly a salt, and belongs to neither division and it will be discussed hereafter.

15. The chemical constitution of all rocks is similar. If rocks are divided into two classes, the first composed of the highly crystalline, usually called primary, such as granite, gneiss, mica slate, porphyry; and the second class composed of rocks, usually called trappean, as bassalt, greenstone, trap, then the great difference in their chemical constitution is this:

The first class, or granitic rocks, contain about 20 per cent. more of silex, and from 3 to 7 per cent. less of lime and magnesia and iron, than the second or trappean class.

16. If the language of geology is borrowed, and rocks which present the appearance of layers, or a "stratified structure," are divided into two classes, fossiliferous and non-fossiliferous, or those which do, or do not contain remains of animals or plants, it will be found that the fossiliferous are neither granitic nor trappean, yet they are to be classed with the last, agreeing with them in containing less silica, and more lime, magnesia, and alumnia.

17. The stratified non-fossiliferous rocks agree in chemical composition with the granitic, and the fossiliferous with the trappean and volcanic.

18. The trappean and fossiliferous contain the most lime and magnesia; the granitic and non-fossilferous, the most silex. The great difference in chemical composition, between the two classes, is produced by lime and magnesia,—two substances, which, more than all others, have been thought to influence the character of soil.

19. The amount of this difference is about from 4 to 7 per cent.; yet notwithstanding this, the general chemical constitution of all rocks approaches so nearly to identity, that this may be laid down, as the first principle in agricultural chemistry, that there is one rock, consequently one soil.

20. To the farmer, all soil is primary. The question then arises, how do rocks and soil affect vegetation? As a consequence of the first proposition, it may be laid down as the second principle of agricultural chemistry—that rocks do not affect the vegetation which covers them.

21. This is opposed to the geological doctrine of the times, and may seem to be opposed to the statement, section 18. The differ-

ence there stated, may be thought to produce corresponding effects in vegetation. This would be true if rocks exerted any influence on soils, due to their chemical constitution. A survey of the geographical distribution of plants, used for food, will show that the common doctrine of the chemical influence of rocks on vegetation, is not so well supported, as to be considered an established principle.

22. The plants used for food are cultivated on every variety of rock foundation which the earth presents. Then cultivation is limited neither by granitic nor trappean, by fossiliferous nor non-fossiliferous rocks. Then product varies not more on different, than on the geological formation. Every where, over every variety of rock, the cultivation of the food-bearing plants, repays the labor of the farmer.

23. Surveying Massachusetts, it is evident the grain crops are not influenced by the peculiar rock formations over which they are grown; for in this state, with the exception of modern volcanic rocks, all the various formations, which the earth presents, are found. Yet no difference in the quality and quantity of crops of rye, oats, barley, wheat, Indian corn, is found which can be attributed to different geological tracts.

24. All plants have a natural limit, a peculiar region, in which, unaided by the human race, they flourish and spread spontaneously. The smaller the limit of this natural boundary—the more difficult is the cultivation of the plant. Yet we find that the natural boundary is passed, and so plants come to live in an artificial region. There is a natural, and there is an artificial "habitat," or region; and this last is either horticultural or agricultural. The first is unlimited, the second is limited by the great external circumstances of temperature and moisture.

25. The extreme north and south limits, which bound the cultivation of the food-bearing plants, are determined wholly by physical, physiological and social causes. Temperature is the great agent, which limits the agriculture "habitat" of the grain-bearing plants.

26. The distribution of plants is governed by the two following laws:

1st. The polar agricultural limits are bounded by lines passing through places of equal summer heat.

2d. The equatorial limits, by lines of equal winter heat.

These lines are called respectively, isotheral, and isochimenal. They by no means coincide. They often cut each other at right angles, and generally, from about 45° north latitude, they are parallel neither to one another, nor to the latitude. They are often highly curved.

And now for the proof of these general laws—beginning with barley, the grass or grain which has been cultivated the farthest north. Its fields are found in the extremity of Scotland, in the Orkneys and Shetland Isles, 61° N.; in the Feroe Islands, 61°—62° 1-2 N.; in Western Lapland, near North Cape, in latitude 70°;

on the borders of the White Sea, in Western Russia, between 67° and 68°, and near to Archangel, in Eastern Russia, about 66°, in Central Siberia, the limit of barley is between 58° and 59° N. There are no extended observations of the temperature of the northern portions of our own continent, and therefore the limit of barley in Northern America is left undefined. But its European line will probably define that which will limit grain cultivation in America.

Tracing a line through the points above named, it is the northern boundary of all the cereals, or grains. A little beyond this line is the boundary of the potato, and the belt between the two, is remarkable. It is the zone between agriculture, and fishing and hunting, between races of men, subsisting on animal, and on vegetable diet, and those whose chief food is animal. The northern cultivation of barley is bounded, if its course is traced, by a very curved line. Is this determined by geological causes, or do causes purely physical erect a barrier to its farther northward advance? The answer will be found, in tracing the temperature of the seasons of the different places, through which the limit of the northern cultivation of barley passes. It will be evident that the line of this limit is isotheral, for the mean temperature, Fahrenheit, is as follows:

	Latitude.	*Year.*	*Winter.*	*Summer.*
Feroe Isles,	61—62°	+45°	+39°	+51°
W. Lapland,	70	+33·8	+21·2	+46·2
Russia, at the mouth of the White Sea,	66—68°	+32	+10·2—8·8	+46·3

Casting the eye on this table, it is evident that the annual or the winter temperature has little influence on the barley limit, and that a mean summer temperature from 46 to 43° is the only indispensable physical condition, to the cultivation of barley. On the Atlantic islands, a mean temperature from 3 to 4° higher is necessary, which compensates for excessive humidity. It is remarkable, that all the cereals have failed in Iceland, though its mean temperature is above that necessary for barley. Nor is this owing to its geological structure. In that, it agrees with the fertile shores of the Mediterranean. It is volcanic. So far as nitrogen, and carbonic acid, and ammonia, may be supposed, to be evolved from the earth, and to contribute to the growth of grain, Iceland should equal fertile Italy. But such is not the fact, and it goes to prove that rocks affect very little the crops grown over them, even when the great physical element, temperature, is as high as necessary. That grains fail in Iceland, is due to the excessively tempestuous rains with which that country is visited. If then, the limits of barley are defined by an isotheral line of 46 1-2° in Europe, that will also limit its cultivation in America. So far as observation has extended, this is true, and the line of boundary is equally curved, and winding. If a similar table for the limits of wheat is constructed, by drawing a line through the most northern places, where this grain has been cultivated, the physical conditions, essential to its cultivation, will be found as follows:

	Latitude.	Mean temperature, Fahr. of the *Year.*	*Summer.*	*Winter.*
Scotland, (Inverness)	58°	+46.3	+57·3	+36·5
Norway, (Drontheim)	64°	+39·5	+59	+23·5
Sweden,	62°	+39·5	+59	+23·5
St. Petersburgh,	60·25	+38	+60·8	+15·6

North latitude 64° appears then, to be the utmost limit of wheat. It is evident by inspection, that this is not determined by the cold of winter; for spring wheat would not be affected by it; and even if sown in autumn, in these far northern regions, the seed would be effectually preserved from the rigors of winter, by that thick mantle of snow, which becomes thicker and more lasting towards the north. The temperature of the air exerts no influence on seeds of plants buried under snow. Nor does the mean temperature of the year exert any effect; it is seen ranging 9°, while the summer temperature varies only 3 1-2°. The summer temperature alone defines the limit of northern wheat cultivation, and this is an isotheral line of 57·4°. Yet it is found, that there are places, where, as in Russia, the means of spring and autumn, both depending on that of winter in part, are too low to allow wheat to be raised under this line of 57·4 degrees. In truth, the relation of climate to cultivation cannot be accurately determined without observations on the mean temperature of the days which elapse between sowing and harvest, and to this point the philosophic farmer should direct his attention. In our country, the isotheral line of 57·4 degrees, starting from Labradore, 51 degrees, and passing between Hudson's Bay and Lakes Superior and Huron, 50 degrees, then turning north it approaches 58 degrees. At Cumberland House, 54 degrees north, Capt. Franklin found fields of barley, wheat, Indian corn. The line approaching the Pacific ocean turns more southerly to compensate the increasing humidity. As the limits of barley mark the boundary between the races of shepherds and hunters and fishers, and thus presents itself in a moral view, so the limit of wheat becomes interesting from coinciding in some parts with that of fruit trees, as apples and pears, and also with that of the oak. The whole aspect not only of agriculture, but also of the orchard and forest changes at once on approaching the isotheral line of 57·4 degrees, the northern limit of wheat. It would be easy to extend these remarks to rye, still the staple food of a large part of the population of Europe, and to oats, little used for food for man out of the "land o' cakes," yet growing in Norway, as high as latitude 65 degrees. Each of these grains has a distinct isotheral line parallel to that of wheat and barley. Indian corn and the potato have each its isotheral line. Turning to the equatorial limits of the grains it will be found, that extreme heat arrests their cultivation. Observations in these regions, and experiments performed by profound vegetable physiologists, confirm this statement. They have proved that the seeds of the food-bearing plants, even after germination has began, can support greater degrees of drought and heat, than ever occur in the hottest climates.

The grains all germinate in a soil of a temperature from 104 to 105 degrees, and require at least from 116 to 120 degrees to arrest this process. Barley ceases to germinate at the lowest temperature. After barley follows wheat, then rye. Indian corn endures the highest heat, viz.: 120 degrees before its germination is arrested. The grains flourish under a mean annual temperature of from 77 to 80 1-2 degrees. Defining their equatorial limits, they are bounded not by lines of equal summer, but equal winter temperature; the reverse of their polar limits. Hence, climate, always determines the sowing season. In Bengal, wheat, barley, oats, are sown in October and harvested in March and April, while rice and maize are sown in May, to be harvested as with us in October. It is this line of equal winter temperature, or rather that of the coolest months, which allows the grains to be cultivated in many places within the torrid zone, and the line of 68 to 70 degrees, which constitutes the tropical limits of wheat culture, varies between 20 and 23 degrees latitude. The other grains enduring from 5 to 7 degrees lower temperature, are found in higher latitudes.

27. The wide belt of our globe, comprised within these limits, extending from 20 to 70 degrees north latitude, presents every variety of geological structure; yet, nowhere, in all this space is the quantity or quality of crops affected, by the chemical nature of the underlaying rocks.

28. A similar principle governs the growth and cultivation of the grain-bearing plants on mountains. Their limits are found at heights, which correspond to the latitude, which marks the isotheral line. In the Swiss Alps, the grains cease growing at the following heights.

Wheat at	3400	feet	corresponding to latitude	64	degrees.
Oats	" 3500	"	"	65	"
Rye	" 4600	"	"	67	"
Barley	" 4800	"	"	70	"

This shows a beautiful correspondence between latitude and altitude, and leads a step farther in the proof of this principle, that rocks do not affect the vegetation which covers them.

29. The space which has thus been surveyed, presents amid great diversity of rocks, a singular identity in chemical composition of the soil. These facts lead to the third principle of agricultural chemistry, rocks have not formed the soil which covers them

30. Everywhere, with the exception of the tops of some mountains, the rocks of the globe are covered from a few inches, to some hundred feet in depth, with gravel, sand, clay, rolled stones, sometimes alternately with each other, sometimes in confused heaps. The best attested, and most universally admitted fact of geology, is, that the loose materials of our globe have been transported, from a few, to many hundred miles from their original situation. With a few exceptions, the soil which now covers rocks, has been derived from places distant, and from rocks distinct, from those on which it now reposes. This is peculiarly true of soil on limestone districts, which does not contain more lime than the soil reposing on granite.

31. Transportation of soil, is a fact so well established, that it needs only to be mentioned. There has been a universal mingling of the loose material, soil, derived from worn down and mingled rocks.

32. The same uniformity of chemical composition characterizes soil, which characterized rocks; that is, great similarity, but not identity, and it is on limited patches only, that soil partakes decidedly of the character of the underlaying rocks.

33. The extensive analyses of soil, excuted by the geological surveyor of Massachusetts, taken from every variety of rock formation, present a remarkable uniformity, both of chemical constitution, and mineralogical composition of the earthy ingredients. The same truth is presented by the analysis of soil from various parts of the globe. It is a conclusion, warranted by the widest examination, that the mineral constituents of 100 parts of the soil of our globe, is composed of sand or silicates 89·28; salts of lime 00·85.—*Dana's Muck Manual.*

Engineering Science.—The tunnel on the line of the Sheffield and Manchester Railway will be 3 miles in length, upwards of 600 feet below the surface or summit of the hill at its greatest height, and in rock formation throughout its entire length. The works were projected and commenced upwards of two years ago, under the direction of Charles Vignoles, Esq. Five shafts were opened, at about half a mile distant from each other, for the purpose of proving the formation, of facilitating the driving of the drift-ways and ultimately, of ventilating the tunnel. Whilst these were in progress, the drift-ways were carried on from each side, or face, of the mountain: the distance, or length, driven, on the eastern side, extending to nearly 1000 yards, and from the next shaft 180 yards. The junction between these two portions of the drift-way was effected on the 17th Sept., and the levels, when checked, on a tie-bench, at the point of meeting, had varied but 9 decimals, or 1 in. nearly, and the range was within less than 2 in. of being geometrically true.—*Weekly papers.*

The Naval Observatory.—We learn from the Boston Courier that Lieutenant J. M. Gillis of the United States Navy, took passage in the Acadia for Europe, and that he goes out vested with full powers by the Secretary of the Navy to purchase a complete set of instruments for the observatory soon to be erected in this city. He has been charged by the secretary to visit the principal observatories in Europe, and to procure from the most eminent makers the following capital instruments:

One sixteen feet Parallactic Instrument, to be mounted in a similar manner to the Pulkowa Refractor; one Transit Telescope for the meridian, of seven feet focal length; one Transit Telescope for the prime vertical, of seven feet in length; one Mural Circle, of five feet diameter; one Transit Circle; together with complete sets of magnetic and meteorological apparatus, with the most mod-

ern improvements. Also a library, embracing all the standard mathematical works; annals of all the observatories; catalogues of stars, nebulæ, etc. etc.—*National Intelligencer.*

THE BOUNDARY.—Captain Talcott of the corps of Topographical Engineers, states, in a recent letter to the Secretary of State, that the extent of the boundary line separating the United States and Territories from the British possessions, and lying between the monument of the St. Croix and the Stony mountains, is estimated as follows for each adjacent state:

Maine, (line as awarded by the King of Holland)	460	miles.
New Hampshire,	40	"
Vermont,	90	"
New York,	420	"
Pennsylvania,	30	"
Ohio,	200	"
Michigan,	740	"
Territory west of Lake Superior,	1150	"
Total length of boundary line,	3130	miles.

The Courier Français, alluding to the contract for the first section of the railroad from Paris to Belgium, says: "This is the second example of English contractors, after having finished railroads in their own country, coming to take part in ours. It is well known that the Rouen railroad, in which English capitalists have an interest, is exclusively directed by English engineers. This is an advantage for France, because several methods in use on English lines, particularly in forming the embankments, are superior to ours, and will in this way gradually become known among us, and be adopted at last generally."

The Commerce says: "Engineers under the direction of the Minister of Public Works, have formed a plan for laying a continuous railroad completely encircling Paris. It is to run at a certain distance from the continuous wall, and form in the whole an extent of 40,000,000 metres. The cost is estimated at 12,000,000 francs at the least. Its object is to establish a direct and rapid communication between all the railroads which sooner or later will diverge from the capital.

ERRATA IN ARTICLE "CANALS OF CANADA."

Page 257, 4th line from top, for "their" read "these;" page 259, 12th line from top, for "lock 100 by 30" read "locks 100 by 20"; page 262, 1st line from top, for "least," read "best;" page 262, 6th line from top, for "7 times," read "3 times;" page 263, 14th line from top, for "$6,600,000," read "$1,600,0000;" page 265, 7th line from bottom, for "desirable," read "possible;" page 264, 3d line from botton, for "eastern," read "western;" page 266, 4th line from top, for "unusual," read "universal."